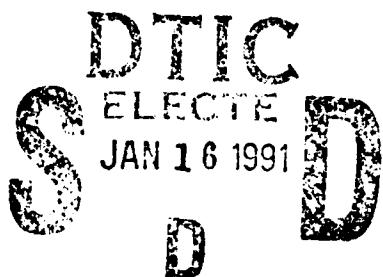


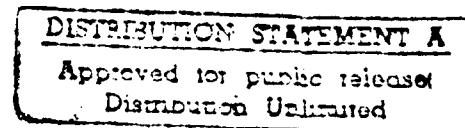
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(2)



ABBREVIATED ANALYSIS (AA)
FOR THE
25 TON ALL TERRAIN CRANE (ATEC)

U.S. Army Engineer School
Fort Leonard Wood, Missouri 65473-6620



1. INTRODUCTION:

a. Background: The acquisition of the 25 ton All-Terrain Crane (ATEC) is essential for the completion of sustainment combat engineer projects. The current 20 and 25 ton crane systems in the U.S. Army inventory are overaged. There are no replacement parts such as engines, transmissions, target converters, axle assemblies and hydraulic pumps, valves and cylinders because these cranes are so old that parts are no longer being made for them. The cranes are presently being made operational only by cannibalization. Typical sustainment construction missions for the ATEC are:

- (1) Vertical construction of buildings such as theater storage warehouses or aviation hangars.
- (2) Horizontal construction which includes moving culverts, poles, concrete, steel and other materials for lines of communication.
- (3) Pile driving for bridges, buildings and loading docks.
- (4) Quarry support operations, moving crushers and rock.
- (5) Bridge construction, moving materials and equipment for standard, non-standard bridges and assault bridges.
- (6) Moving heavy supplies such as 100 kw generators or connex containers.
- (7) Recovering vehicles in rear areas.

At present all of the Army's 20 and 25-ton crane variants are overage (operating beyond their original 15 year expected life) and must be replaced. If these cranes are not replaced, the Army will not be able to complete its sustainment engineer missions, because there are no repair parts available to keep these cranes functioning. The Army needs to replace all 20 and 25-ton cranes in the inventory to an Abbreviated Acquisition Objective (AAO) of 1907. The Initial Issue Quantity (IIQ) is 1557 cranes with Lin No. F39378, F43414 and 43429.

b. Objective: The objective of this analysis is to evaluate the alternative means for meeting the ATEC requirements for U.S. Army needs as stated in the ATEC ROC, and to recommend the most effective alternative system. (This Abbreviated Analysis document is in support of the Required Operational Capabilities (ROC) for the All-Terrain Crane (ATEC)).

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2. ANALYSIS:

a. Analysis of Mission Needs, Deficiencies, and Opportunities.

(1) Mission Needs: Within the AirLand Battle doctrine, threat systems must be defeated through the application of fire and maneuver. Our weapons systems require mobility to assault, to close with and destroy the Threat, and to conduct rapid counterattacks. Support of forces near the battle area will require an ATEC capable of operation over all types of terrain, as well as capabilities for lifting and movement of heavy supply and maintenance loads, and performance of engineer combat tasks. A requirement exists for a hydraulically operated All-Terrain Crane (ATEC) that can travel on all roads (improved and unimproved) and has some cross country maneuverability. The crane must have a lifting capacity of 25 tons for loading, pile driving, and excavating capability and for materiel handling and construction support for all types of Army units on varying types of terrain.

(2) Deficiencies: The current military crane systems are overaged. Both wheel-mounted and truck-mounted cranes currently in the Army inventory have a low availability rate because such a diversity of makes and models affects repair part availability and because most cranes have exceeded their projected life expectancy. All of the 20 ton truck-mounted cranes with lattice boom exceeded their projected life span as of 1986. 74% of the 25 ton commercial construction equipment (CCE) hydraulic truck-mounted cranes will reach their projected service life expectancy by 1994. Engines and other repair components for these cranes are no longer in production. Another deficiency is the present lack of adequate crane system mobility. No truck-mounted cranes in the inventory have capability to travel over unimproved road surfaces and off-road. Further, the present truck-mounted crane mobility on improved roads is severely limited due to vehicle oscillation and instability at higher speeds (Independent Evaluation Plan for the All Terrain Crane (ATEC) during the Proof of Principle Phase, USAES, Ft Belvoir, VA, Appendix B, p. B-1). These deficiencies limit the engineer capability to support maneuver and combat support units. A timely decision for selection of the best alternative for replacing the overage crane fleet is required.

(3) Opportunities: The All-terrain Crane will maximize commercial state-of-the-art technological advances in design and minimum performance benefits. The ATEC will be a commercial design with a rated lift capacity of 25 tons. It will be a hydraulically operated crane equipped with a telescoping boom and independently controlled outriggers. In addition to lifting, the crane will be capable of performing clamshell and pile driving

operations. It will offer all-terrain capability by utilizing the best on-road performance of a truck-mounted crane and the off-road capabilities of a rough terrain crane. The All-Terrain Crane will have the speed and off-road terrain mobility required to support units on the AirLand Battlefield. The present industry technology will allow the ATEC to be procured as a Non-Developmental Item (NDI).

b. Threat and Operational Environment:

(1) Threat. The All-Terrain Crane will be operated in or near the same environment as other support systems used to support combat forces. The crane will be vulnerable to the entire spectrum of threat weapons effects from small arms and artillery to sophisticated directed energy weapons and NBC systems. By itself, the ATEC will not be a primary threat target unless directly involved with or in the immediate vicinity of a threat priority target, but it will be attacked as a target of opportunity. With threat doctrine emphasizing combat operations throughout the Corps area, the ATEC will also be subjected to direct action by deep penetrating or inserted threat combat formations, special operations teams, and saboteurs.

(2) Operational Environment: During the conduct of combined arms operations, U.S. forces will be required to operate in a wide variety of operational and battlefield environments. The operational and battlefield environments of Europe, Southwest Asia, and Central Latin America are considered to be the most likely.

c. Constraints:

(1) Time Frame: Alternatives considered in the analysis were restricted to off the shelf systems available for fielding as to Fiscal Year 1989.

(2) Force Structure: This Abbreviated Analysis was based upon the engineer force structure stipulated in the Total Army Analysis (TAA) 92. That force structure was considered fixed and alternative systems must not require substantial changes in engineer force structure with regards to personnel or unit structure.

(3) Reengineering/remanufacturing of 20 and 25 ton cranes. In 1986 USATACOM, AMSTA-FHV Warren, Michigan, 48090, examined the possibility of reengineering or remanufacturing the Army crane inventory (Including LIN No. F39378, F43414 and F43429). It was discovered that there were no replacement engines for these cranes available from any manufacturer and that new engines would have to be fitted. Most models had problems in that either engines and/or transmissions, torque converters, axle

assemblies and hydraulic pumps, valves and cylinders were no longer made. The TACOM decision was: "There appears to be no alternative to improve the readiness posture of the active Army other than early procurement of replacement cranes" (16 Apr 86 letter from AMSTA-FHVA to Commander, USAMC, AMCSM-WCS, p. 3). Therefore this AA does not examine the reengineering or remanufacturing of overage and non-supportable 20 and 25 ton cranes as a viable alternative.

d. Operational Concepts:

(1) Organizational Plan: ATEC will be employed and supported by selected divisional and nondivisional Engineer, Quartermaster, Transportation, and Maintenance units. Ultimately the ATEC will be a one-for-one replacement for the existing military design 20-ton wheel-mounted crane (RT), the 20-ton truck-mounted crane, and the 25-ton CCE truck-mounted crane. Peacetime operations are based on twenty-two, 10-hour days per month. Wartime operations are based on fifteen-day missions averaging 10 operating hours per day. In the wartime scenario, two shift operations may be employed. The ATEC will be operated under day, night, and all weather conditions normally encountered at construction, maintenance and bridging sites, and resupply points. The usage profile is as follows:

<u>TASKS</u>	<u>USAGE PROFILE</u>			
	<u>Peacetime</u>		<u>Wartime</u>	
	<u>Operations</u>	<u>30 Day</u>	<u>30-Day Scenario</u>	<u>Hours</u>
Equipment/Units Relocations	5	11	33	100
Operating Time*	75	165	46	136
Set-up/Lifting/Lowering	(60)	(132)	(38)	(114)
Loading				
Excavating/Clamshell	(8)	(18)	(4)	(12)
Pile Driving	(7)	(15)	(4)	(10)
Stand By	20	44	21	64
TOTALS	100	220	100	300

*Included in the set-up, lifting, lowering, loading, excavation, and pile-driving tasks is the travel at job sites which will require the ATEC to move over unimproved terrain normally encountered at combat support employment sites.

(2) Climatic and Terrain Conditions: The ATEC will be operated worldwide over varied terrain ranging from paved roads to soft surfaces (sand, snow, and mud). Off-road terrain may exhibit little or no surface improvements. Operations will be at temperatures as low as minus 25 degrees F to as high as 120 degrees F.

<u>Climatic Conditions</u>		<u>Terrain Conditions</u>			<u>Peace</u>
<u>Climatic Design</u>	<u>Types (AR 70-38)</u>	<u>Terrain</u>	<u>% Usage</u>	<u>Mileage</u>	
<u>War</u>					
Hot	15%	Primary Roads ¹	40%	88	
400					
Basic	80%	Secondary Roads ²	45%	99	
450					
150		Off-Road ³	15%	33	
Cold	5%				
<hr/>					
1000				220	

1. Primary Roads - Two or more lanes, all-weather, maintained, hard surface (paved) roads with good driving visibility used for heavy and high density traffic.

2. Secondary Roads - Two lanes, all-weather, occasionally maintained hard or loose surface (e.g., paved, large rock, crushed rock, gravel) roads intended for medium-weight, low density traffic.

3. Off-Road - Vehicle operations over trails or cross-country.

Trails - One-lane, dry-weather, unimproved and seldom maintained loose surface roads intended for low-density traffic.

Cross-Country - Vehicle operations over terrain not subject to repeated traffic and where no roads, routes, well-worn trails, or man-made improvements exist.

e. Specific Functional Objectives:

(1) The ATEC on-road capability will be safe operation at highway speeds of at least 40 mph on primary and secondary roads with <1% grades and at least 2 mph on 30% grades (without trailer).

(2) The ATEC will have an unimproved road speed of 20 mph.

(3) The ATEC will have cross-country movement capability.

(4) The ATEC will be able to ford streams up to 30" deep without preparation.

(5) The ATEC will be capable of safely ascending and descending a 30% longitudinal slope or traversing a 15% side slope without hook load.

(6) The ATEC will have high ground clearance.

(7) The ATEC will have minimal oscillation when traveling in correct travel configuration.

(8) The ATEC will be air transportable by C-5 and C-17 aircraft.

(9) The ATEC RAM availability will be .87 for peacetime and .83 for wartime.

(10) The ATEC boom will telescope to 70 feet.

(11) The ATEC lift capacity will be at least 25 tons.

(12) The ATEC outriggers will be hydraulic.

f. Systems Alternatives:

(1) The base case will be the present 25-ton truck mounted, hydraulically operated crane and the 20-ton truck or wheel mounted crane variants.

(2) Alternative 1 will be the 25-ton All-terrain hydraulic crane with telescoping boom and independently operated outriggers.

g. Systems Characteristics, Performance and Effectiveness

(1) Systems Characteristics:

(a) The present 25-ton truck mount cranes are capable of operating with a hook, 3/4 cubic yard clamshell, 3/4 cubic yard dragline, 1 cubic yard concrete bucket, wrecking ball and 7000 pound diesel-operated pile driver. The 25-ton truck mounted crane is hydraulically operated with cable operated attachments.

(b) The present 20-ton truck and wheel mounted crane variants are capable of operating with hook, 3/4 cubic yard clamshell, 3/4 cubic yard dragline, 1 cubic yard concrete bucket, wrecking ball, and 7000 pound diesel-operated pile driver. The 20-ton truck and wheel mounted cranes are hoist/drum operated.

(c) The 25-ton ATEC will be of a commercial design with a rated capacity of 25 tons. It will be a hydraulically operated crane equipped with a telescoping boom and independently controlled outriggers. In addition to lifting, the crane will be capable of performing clamshell and pile driving operations. The term "ALL TERRAIN" is an industry expression, which describes the latest in crane technology offering both the on-road performance of a truck mounted crane and the off-road capabilities of a rough terrain crane.

Primarily this is accomplished by incorporating rough terrain tires on a carrier chassis with a lock out feature on the suspension system.

(2) Performance: (See Table 1) The major performance effectiveness factors are:

(a) Mobility, including on-road and off-road capability and transportability.

(b) Logistics.

(c) Reliability and maintainability (RAM).

(d) Operation Characteristics, including boom length, lift capability, excavation capability, and pile driving capability.

(3) Effectiveness: The Army's specific Functional Objectives are laid out in Table 1, Alternative Comparison for the 25 Ton All Terrain Crane ATEC, under the performance categories of Mobility Logistics, RAM and Operational Characteristics, Table 2, Comparison of the 25-Ton All Terrain Crane Alternatives on Minimum Needs, shows that the present 25 ton and 20 ton crane variants combined meet no more than six of the Army's needs, while the 25-ton All Terrain Crane meets all of the Army's 15 minimum needs. In terms of mobility, logistics, RAM and operational characteristics the present crane variants in use by the Army today do not meet the Army's minimum needs (see Table 2). The Rough Terrain Crane is the only crane with any off-road capability. The other present crane variants have no off-road capability. None of the present cranes have both the ability to move with the maneuver force on-road, and move cross-country as well. The present 20 to 25 ton crane variants and the 25 ton terrain ATEC do the basic jobs of lifting, excavating, and pile driving about the same. However, because the 25 ton All Terrain Crane has a telescoping boom, it will be able to set up and adjust to various tasks quicker than "lattice type cranes".

(a) In terms of Logistics, the present Army 20 and 25 ton cranes family create significant repair parts problem. There are over ten different models. The majority of these models do not have major engine and transmission parts available. These cranes have to be cannibalized to keep them working. The new 25-ton all terrain crane is the best solution to the logistics problems. Since fielding the ATEC will decrease the number of crane models to be supported from over ten to one, a substantial reduction in the logistics inventory is likely to occur. Modification of 20-25 ton cranes on hand has not been accomplished due to the expected fielding of the ATEC. Therefore, any delays in fielding of the ATEC will only magnify current related maintenance and repair problems.

(b) The operational availability of the present 20 and 25 ton crane variants is at best .70. The 25-ton all terrain crane will provide an availability .83 wartime and .87 peacetime. The 25 ton all terrain crane will provide the best availability for the Army. The 25-ton all terrain crane will also be easier to operate and maintain than other crane variants because of its more modern human factors engineering design.

(c) The present 20 and 25 ton crane variants in use by the Army today meet only five to six of the Army's needs for successfully completing its sustainment construction mission. The 25 ton All Terrain Crane meets all of the Army's needs and is the best viable alternative presently available.

h. Costs. The purpose of this section is to provide a cost analysis to support a Department of Army decision to replace the crane fleet to meet the Army's all terrain mobility needs for a 25 Ton Crane. Costs are expressed in constant FY 90 dollars and current dollars over the crane's 15 year operational life for Research and Development (R&D), Investment, Fielding and Sustainment. Past years R&D are considered "sunk" costs for this analysis. Both the base case cranes and the 25 Ton ATEC are considered to have a useful life of 15 years. A summary of life cycle costs is provided in TABLE 3. A more detailed breakdown of the base case mix is show in TABLE 4.

(1) The basecase cost reflects the costs associated with the replacement of each model of the present cranes if they were to be replaced by a new model. It should be apparent that the cost of repairing the present basecase vehicles and the cost of procuring replacements for the basecase fleet will be almost equal. This is due to the condition of the present fleet.

(2) The new 25 Ton ATEC will have a total constant dollar investment cost of over 361 million dollars for 1907 cranes. The base case replacement mix of 20 and 25 ton cranes will have a total constant dollar investment cost of over 266 million dollars for 1907 cranes. Considering constant investment cost alone, the 25 Ton ATEC would cost 95 million dollars more than the base case cranes.

(3) The new 25 Ton ATEC will have a total constant dollar fielding cost which is 6 million dollars higher than the total constant fielding costs for the base case cranes.

(4) A careful analysis of TABLE 3 reveals the following:

(a) The Life Cycle Costs for total sustainment of the base case cranes, using FY 90 constant dollars, is estimated to be 641 million dollars as opposed to 605 million dollars for the 25 Ton ATEC (See Total Sustainment).

(b) The Life Cycle sustainment Costs for military personnel for the base case cranes, using FY 90 constant dollars, is estimated to be 427 million dollars as opposed to 372 million dollars for the 25 Ton ATEC (See Military Personnel).

(c) Evaluation of paragraphs 2h(4)(a) and 2h(4)(b) above shows an overall decrease in the total sustainment costs of 36 million dollars. The rationale for the decrease in total sustainment costs for the 25 Ton ATEC when compared to the base case cranes is based on the better RAM characteristics for the 25 Ton ATEC which, in turn, result in a requirement for fewer maintenance personnel.

(5) Findings, based on the above analysis, although the total Life Cycle Cost (constant dollars) for the ATEC is 66 million dollars higher than for the base case cranes, the following are additional advantages of the 25 Ton ATEC over the base case cranes which justify procurement of the 25 Ton ATEC:

(a) Better RAM characteristics.

(b) The ATEC will be a high density item as opposed to the base case's three low density items and will thus improve the crane logistics problem of maintaining a multiple crane parts inventory.

(c) The replacement of three (3) cranes now in the inventory with one (1) crane (the ATEC) will limit the number of repair part line items needed to support the equipment.

(d) The ATEC will meet the Army's requirements for speed and mobility which are not satisfied by the base case cranes.

(e) Operators and maintainers remain the same for the base case cranes and the 25 Ton ATEC and, therefore, do not impact on the procurement decision or strategy.

i. Uncertainties: There is no question that the market place will be able to produce a 25-ton all terrain crane to meet the Army's needs. The technology presently exists to meet all the 25-ton all terrain crane requirements.

j. Analysis of Preferred Alternatives: None of the cranes in the Army present inventory are all terrain cranes. An initial survey of the present market shows that 25-ton all terrain crane can be procured with very small R&D costs. Since the old 25-ton and 20-ton designs currently used do not meet the Army's mobility, logistics, and RAM needs, the proposed 25-ton All Terrain Crane is the only viable alternative. The 25-ton ATEC is the preferred alternative in terms of meeting the Army's needs. Therefore, it is recommended that the Army proceed immediately on a Non Development Item (NDI) procurement on the 25-ton all terrain crane.

Summary:

None of the present U.S. Army crane inventory meets its needs for mobility, logistics or RAM. A new 25-ton ATEC is the preferred alternative because it most closely meets the Army's need both from

an operational standpoint and timeliness, since it can be acquired as an immediate NDI procurement.

Table 1

ALTERNATIVE COMPARISON FOR THE
25-TON ALL TERRAIN CRANE (ATEC)

Requirements (Spec Functional Objectives)	Present 25-Ton Crane Variants	Present 20-Ton Crane Variants	Proposed 25-Ton All Terrain Crane
i. Mobility			
a. On-Road Capability			
(1) Top highway speed (40 mph minimum)	No. (25 to 40+ mph)	No. (25+ mph)	Yes, (45+ mph up to 55 mph)
(2) Unimproved road speed	Yes. (20 mph)	Yes. (20 mph)	Yes. (20+ mph, equal to all Rough Terrain (RT) cranes, but better than all truck cranes).
b. Off-Road Capability			
(1) Cross Country Movement	No. Very limited movement, easily gets stuck.	No. Very limited except for Rough Terrain (RT) models.	Yes. Good movement, speeds or up to 15+ mph, dictated by the kind of terrain.
(2) Fording Capability (30' deep)	No	Yes	Yes
(3) Grade Climbing	No. less than 13.3% longitudinally	No. less than 13.3% longitudinally	Yes. 30% longitudinally
(4) Ground Clearance	Low ground clearance on commercial road tires.	Low ground clearance on commercial road tires. RT cranes have better clearance.	High ground clearance, 600 as RT models.
(5) Requirement for On-road Oscillation free movement (virtually none)	No. Oscillation begins at 25+ mph.	No. Oscillation begins at less than 20 mph.	Yes; no oscillation in correct traveling configuration.

Table 1 (Cont.)

<u>Requirements (Spec Functional Objectives)</u>	<u>Present 25-Ton Crane Variants</u>	<u>Present 20-Ton Crane Variants</u>	<u>Proposed 25-Ton All Terrain Crane</u>
1. Air Transportability	Yes	Yes	Yes
2. Logistics (only 1 model in inventory is desired)	2 models of cranes. Makes parts inventory large, some major parts are difficult to get.	5 models of truck mounted cranes. Makes parts inventory high and many major parts are no longer available.	1 model (simplifies parts logistics inventory).
3. RAM			
a. Availability (83% wartime 87% peacetime)	No, 70% or less	No, 70% or less	Yes, 83% wartime 87% peacetime
b. Age of equipment	74% overage by 1989	100% overage by 1986	New
4. Operation Characteristics			
a. Boom Length	No, Solid, segments 30 to 90 ft, must be assembled. Some telescoping booms.	No, Solid, segments 30 to 90 ft, must be assembled.	Yes, Telescoping to 70 ft
b. Lift Capability			
(1) Maximum 25 tons	Yes	Yes	Yes
(2) Outriggers (Hydraulic)	Yes	Yes	Yes
c. Excavation Capability	Yes	Yes	Yes
(3/4 cu. yd)			
d. Pile Driving Capability	Yes	Yes	Yes
e. Maintenance Training	No, Maintenance training difficult due to lack of (Hands on)	No, Maintenance training difficult due to lack of parts.	Yes, Easier maintenance operation training due to state-of-the-art construction and human factors engineering.

Table 2
COMPARISON OF THE 25-TON
ALL TERRAIN CRANE ALTERNATIVES OF MINIMUM NEEDS

	<u>Present 25-To Crane Variants</u>	<u>Present 20-Ton Crane Variants</u>	<u>25-Ton ATEC</u>
1. Mobility			
a. On Road			
(1) Highway Speed	0	0	1
(2) Unimproved road speed	1	1	1
b. Off Road Capability			
(1) Cross Country Movement	0	0	1
(2) Fording Capability (30' deep)	0	1	1
(3) Grade Climbing Capability	0	0	1
(4) Ground Clearance	0	0	1
c. Air Transportability	1	1	1
2. Logistics			
(1 model only as needed)	0	0	1
3. RAM			
a. RAM	0	0	1
b. Age of equipment	0	0	1
4. Operational characteristics			
a. Boom length (telescoping)	0	0	1
b. Lift Capability	1	1	1
c. Excavation Capability	1	1	1
d. Pile Driving capability	1	1	1
e. Training Ease	0	0	1
Total Score	5	6	15

1 = meets needs

0 = does not meet needs

Table 3

25-TON ALL TERRAIN CRANE
 * LIFE CYCLE COST IN FY 90 CONSTANT/
 (CURRENT) DOLLARS, IN MILLIONS.

	<u>Base Case</u>		<u>25 Ton ATBC</u>	
	\$ 0M	\$ (0M)	\$1M	(1M)
Research and Development				
Investment	266M	(320M)	361M	(435M)
Military Construction	0M	(0M)	0M	(0M)
Fielding	36M	(43M)	42M	(50M)
Total Sustainment	641M	(975M)	605M	(913M)
Military Personnel	427M	(682M)	372M	(594M)
Other Sustainment	214M	(293M)	233M	(319M)
TOTAL	\$943M	(\$1338M)	\$1009	(1399)

*Based on 15 Year Useful Life of Equipment

TABLE 4

Summary of Costs

Costs in Thousands

	<u>F39378</u>	<u>+ F43414</u>	<u>+ F43429 = BASE CASE</u>	<u>ATEC</u>
DEVELOPMENT				
1.0 FY90 Constant	N/A	N/A	N/A	N/A
Current Dollars	N/A	N/A	N/A	N/A
PRODUCTION				
2.0 FY90 Constant	134,693	10,488	120,484	265,665
Current Dollars	162,214	12,495	145,086	319,795
MILITARY CONSTRUCTION				
3.0 FY90 Constant	N/A	N/A	N/A	N/A
Current Dollars	N/A	N/A	N/A	N/A
FIELDING				
4.0 FY90 Constant	20,337	1,267	14,608	36,212
Current Dollars	24,188	1,501	17,333	43,022
SUSTAINMENT				
5.0 FY90 Constant	380,576	19,315	240,888	640,779
Current Dollars	580,946	29,247	364,329	974,522
TOTAL				
FY90 Constant	535,606	31,070	375,980	942,656
Current Dollars	767,348	43,243	526,748	1,337,339
				1,009,074
				1,399,001